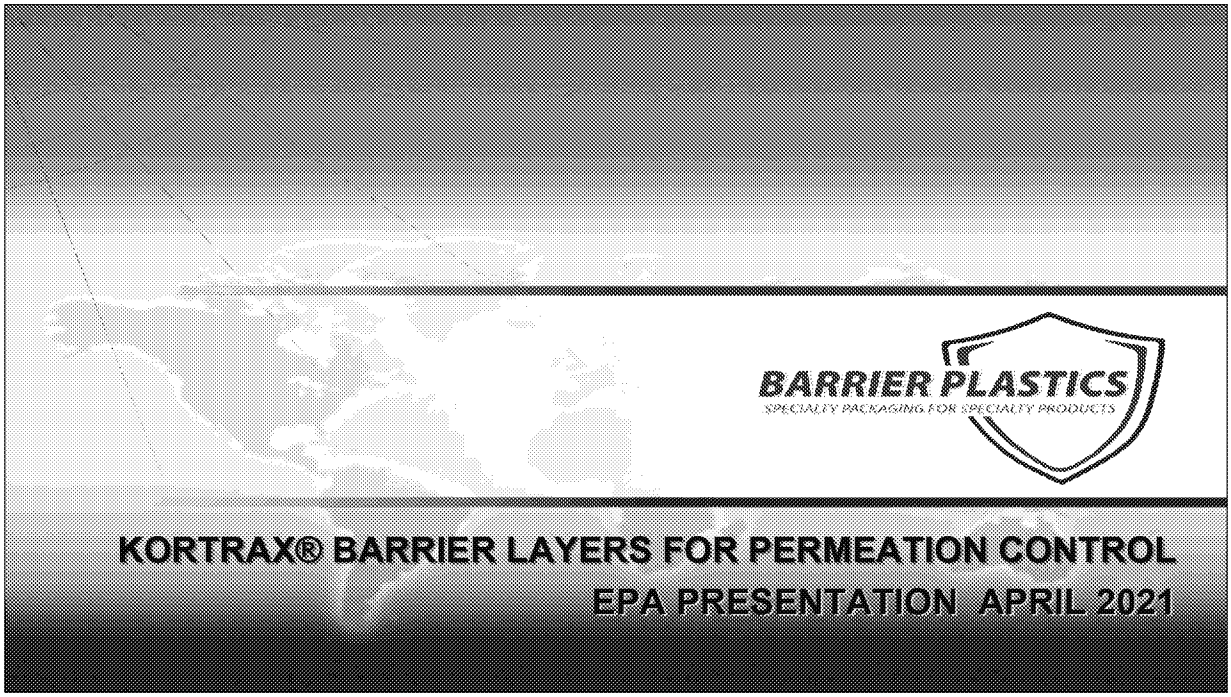
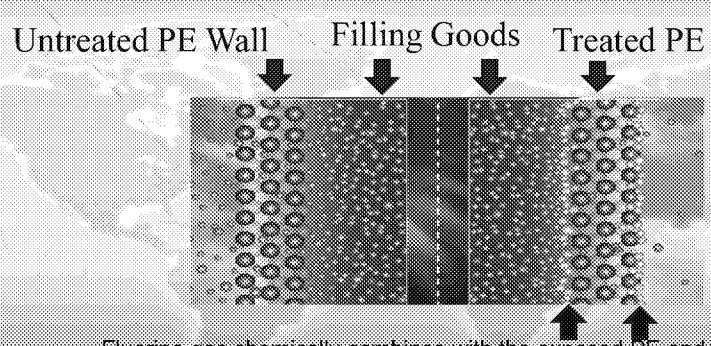

BARRIER PLASTICS
SPECIALITY PACKAGING FOR SPECIALITY PRODUCTS
KORTRAX® BARRIER LAYERS FOR PERMEATION CONTROL
EPA PRESENTATION APRIL 2021

TYPES OF BARRIERS

- **Fluorination**
  - Plastic is exposed to Fluorine gas that reacts with the surface of the plastic forming a fluoropolymer seal.
  - Semi-Permanent and non-reversable
- **EVOH** = ethylene vinyl alcohol
  - Layers of non-permeable material within the HDPE container in a multilayer machine.
  - Minimum five- or six-layer machines
- **Nano-silicates**
  - A compound of nanocrystalline quartz and a polyamide that is added to the entire drum (mono-layer) that blocks the migration of permeable material.
- **Polyamides (PA)**
  - Nylon compounds that have varying formulations and chemical resistance.
- **Kortrax®**
  - An exclusively engineered material based on modifications to polyamide chemistry.
  - An engineered version of nylon that forms laminar structures within the polyethylene matrix thus impeding permeation. This material can be added at 5-18% depending on needed resistance. It offers the solvent permeation control that fluorination gives plus the O2 and H2O barrier of EVOH. And it is fully recyclable, code 2.

FLUORINATION BARRIER TECHNOLOGY



Fluorine gas chemically combines with the exposed PE and seals it off with fluoropolymer compounds.

FLUORINATION

- Only Semi-Permanent – sloughs off into lading
- Additional handling necessary
- Done by off-site contractor increasing lead times
- Multiple levels of treatment with increasing cost per level -
  - Treatment is done under heat and pressure; the longer the exposure time, the higher the 'level'.
  - Inhance Technologies

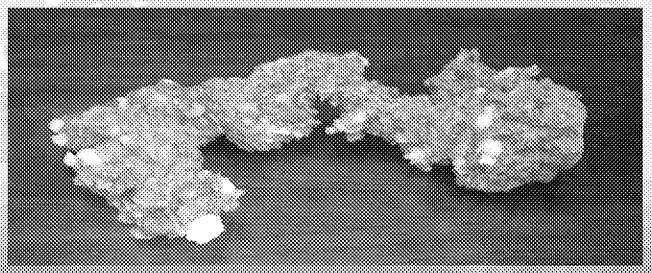
FLUORINATION

- Fluorine will travel w HDPE -
  - High level of PFOS, PFAS compounds on inner and outer surfaces
  - EPA as of 3/5/2021 'encourages' moving away from fluorination
- Fluorination does not inhibit O2, CO2 and H2O permeation…that is permeation INTO the lading.
- Sole US provider for post-manufacturing treatment (Inhance)

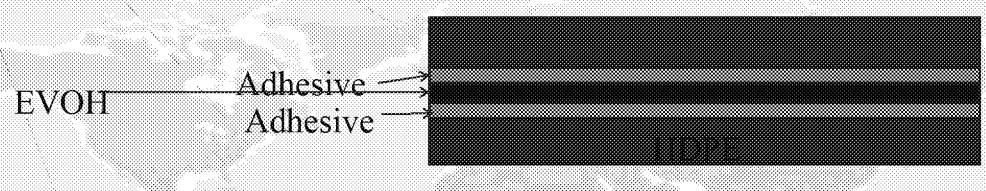
EVOH MULTI-LAYER

- Specialized equipment and handling needed—six extruders and feed systems
- Difficult to "tailor" the amount of barrier
- Expensive equipment and handling
- Requires an adhesive to bind EVOH to the HDPE which hinders reuse

- Glob from a plastic extruder at a global recycling facility. Can't recycle this EVOH plastic in a normal recycling facility. Not a sustainable solution as the containers must be burned or buried.



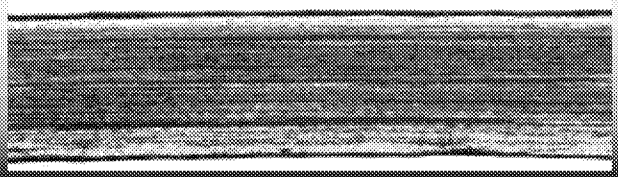
TYPICAL 5 LAYER EVOH MULTI-LAYER CONSTRUCTION



The EVOH halts the permeation, but the chemical still permeates the inner layers potentially weakening the walls of the container and contaminating the filling goods.

NANO-SILICATE BARRIERS

- Polyamide and nanosilicate blended into polyolefin (PE or PP)
- Hyperier® from LG (Korea) is the most known and used
- Under optimal and narrow processing procedures they form a barrier layer that hinders the migration of materials into or out of the container
  - When optimized they can be used in a monolayer system



NANO-SILICATE BARRIERS

- Nanosilicates require higher let down ratio additive rates (LDR) of 18-25% of the total weight of the polyolefin:
  - The high additive rate may result in lower UN/DOT drop test results as fracturing at -18C is more likely.
  - The nanosilicate itself does not necessarily hinder recycling and reclamation of the polyolefin, but at the high LDR it is basically “dirt” that needs to be separated in order to obtain a higher value recycled resin (PCR).
  - Silicate will quickly wear extruder mixing screws forcing replacement.

KORTRAX® BARRIER RESIN (BR)

The Effective Sustainable Barrier Alternative to EVOH and Fluorination

- **KORTRAX® BR**
  - Kortrax® is unique & proprietary Barrier Resin additive to HDPE, LDPE and PP
  - Compounded in Charlotte, NC w raw materials produced in KY and TX
  - Is based on highly engineered & modified grades of Polyamides & thus is inert
  - Barrier is permanent = Shelf life not an issue
  - FDA, EU and USP 661 Compliant = Human Safe
  - No Post-Manufacturing Treatment = Eliminates Additional Transportation, Hassle and Emissions
  - No impact on recycle stream = Code 2
    - Regrind and PCR
- **NO PFAS, PFOS COMPOUNDS**

KORTRAX® PRODUCT TECHNOLOGY

- **How Does It Work?**
  - The barrier technology is a combination of a barrier additive – KORTRAX® (BR) together with an appropriate HDPE extrusion blow molding (EBM) production technology.
  - By processing under well defined conditions in adapted extrusion equipment, Kortrax® BR is stretched into thin layers in a HDPE matrix.
  - In this way a Kortrax®/HDPE MONO-LAYER structure is originated to guarantee improved gas vapor (O_2, H_2O & CO_2) and permeation results.
  - Protects the plastic from stress cracking agents reducing the likelihood of leakage and drum failure.

KORTRAX® BARRIER LAYERS

- Kortrax® Barrier Layers create a 'tortuous path' within the container (i.e., Baritainer®) to prevent escape of potentially hazardous materials (e.g., volatile organic compounds = VOC's)
  - There are both UN and DOT regulations on the allowable amount of permeation plastics can have:
    - 2% by weight except poisons which are 0.5% for US DOT
- Protects the plastic from softening and weakening thus avoiding paneling and stack collapse.

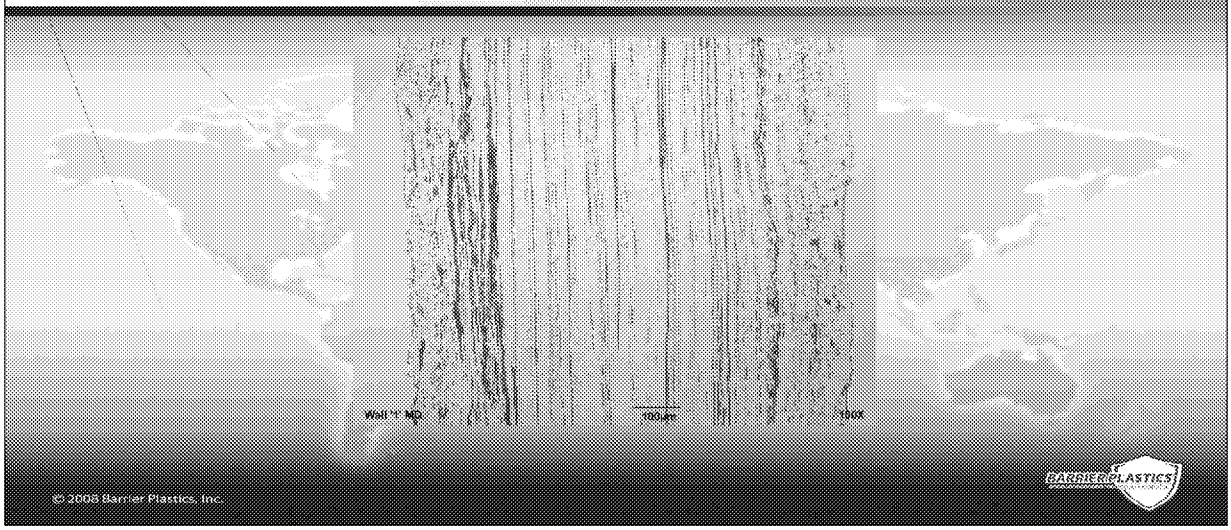
KORTRAX® COMPARISON W HDPE

- No Impact on HDPE Properties:
  - Printability
  - Mechanical
  - Colorants
  - Seal Properties

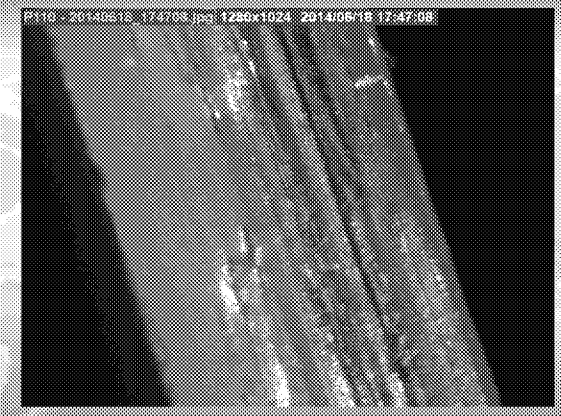
KORTRAX® MICROGRAPH

- Kortrax® 9%

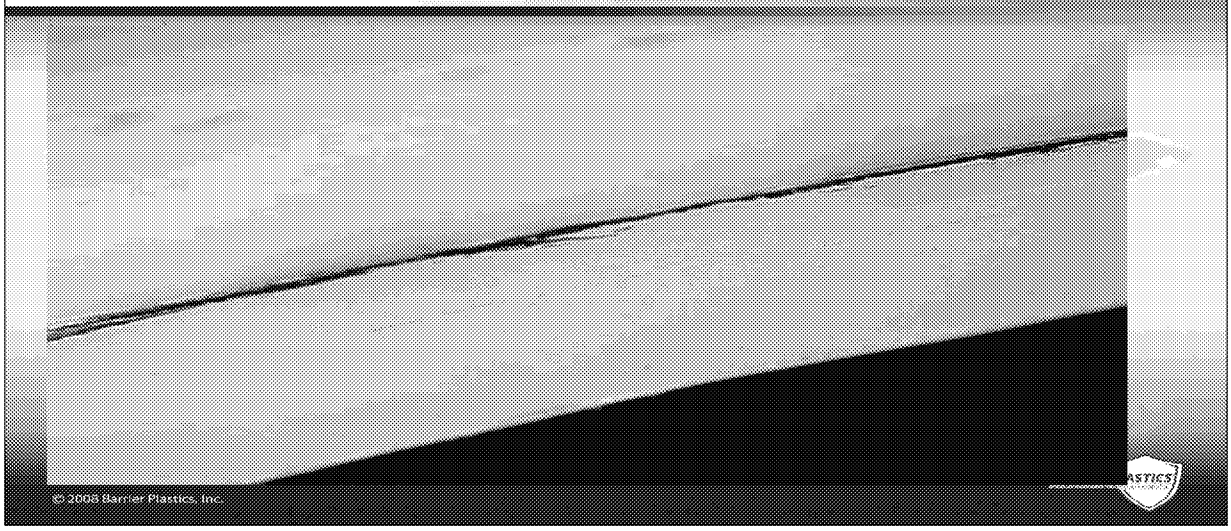
KORTRAX® BARITAINERS®



KORTRAX ® BR CONTAINER WALL DISTRIBUTION

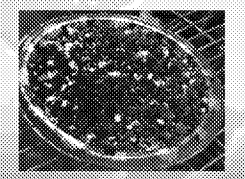


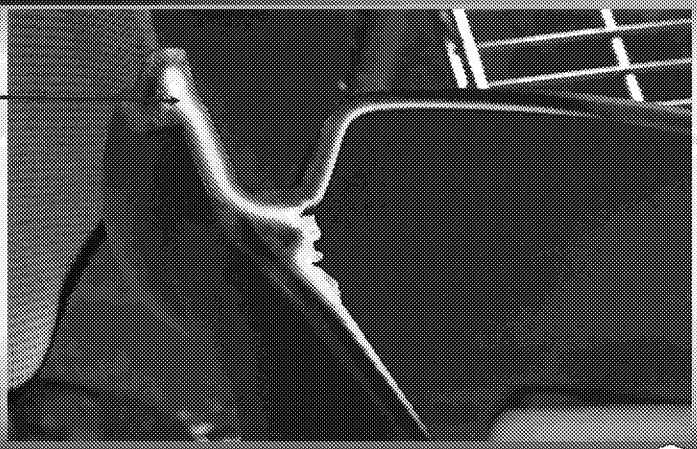
4.2% LDR KORTRAX® in a MULTI-LAYER DRUM



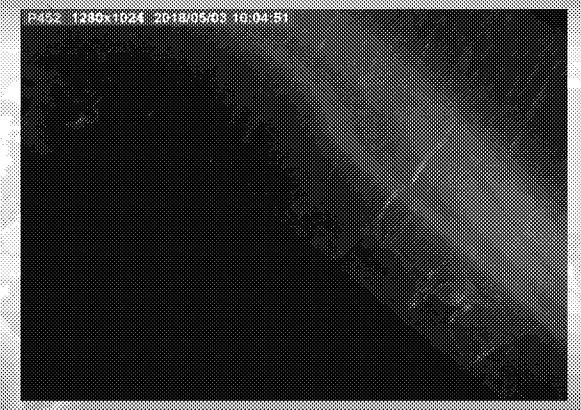
KORTRAX® BR OPTICAL TRACER

- This is Kortrax® w FDA optical brightener in a 55g (208L) HDPE drum.
- It allows for instant visual verification of Kortrax® presence and distribution in the drum and in the regrind.





KORTRAX BR OPTICAL TRACER



In Summary…

- PA, Nano-Silicates, EVOH and Fluorination methods are all effective against permeation and are either permanent or semi-permanent.
- However,
  - **The Fluorination Process itself creates PFAS, PFOS dangerous compounds known as "forever chemicals" (EPA) that travel w HDPE in PCR stream.**
  - **Nano-Silicates require a high amount of LDR, are problematic in PCR and wear down EBM's.**
  - **EVOH inhibits the reuse of the resin—AgChem companies thru ACRC recycle the pesticide bottles to make them into non-contact plastic parts but EVOH M/L does not support this action and is thus discouraged by the ACRC.**

In Summary…

Kortrax® bestows the benefits of both barrier technologies without the recycling problems of EVOH and the safety issues with Fluorination